

Keynote Address  
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Thank you very much, John, for that generous introduction.

So the President of the National Academy of Engineering is to speak today to the National Humanities Alliance. Perhaps a bit incongruous, it reminds me when I was a kid I used to watch Victor Borge on TV. He used to occasionally refer to himself as the "music critic for Mechanics Illustrated." So I may be a little bit in that situation.

But considering that, I decided that espousing my own views about the humanities might not be the best use of your time today. However, let me assure you that they are very positive. The humanities, I believe, are indispensable for understanding what makes us human, giving deeper meaning to our lives, making us better citizens of our nation and world and, indeed, informing the dialogue about policy and technology.

If you will forgive me, I am going to begin with a bit of a history lesson. It's going to be about how and why our federal government supports scientific and engineering research and education. On November 17, 1944, President Roosevelt wrote to Vannevar Bush. His letter stated, "New frontiers of the mind are before us, and if they are pioneered with the same vision, boldness and drive with which we have waged this war, we can create a fuller and more fruitful employment and a fuller and more fruitful life."

FDR asked Vannevar Bush, the former Dean of Engineering at MIT, who was largely responsible for rallying the industry, scientific and engineering communities for the war effort, to form a committee and propose a plan by which the scientific community that had contributed so richly to the pending allied victory could be harnessed to improve the nation's economy, health, security and quality of life after the war was done.

Astonishingly, by July 9, 1945, just nine months later, Bush had completed the task and submitted the report to, of course, President Truman. That report was entitled "Science, the Endless Frontier." This report proposed what was a radical

and unique way of accomplishing the mission at hand. Unlike any other country in the world, the United States should make our universities the core of our national research enterprise.

Every dollar spent in this way would do double duty. It would pay for the conduct of research, the results of which would be openly accessible to the public and it would simultaneously support the education of students, the next generation of scientists and engineers. This is a simple and elegant system unmatched, at least until recently, in the rest of the world, and it has paid enormous dividends to our nation.

I would like to also quote one other very important but usually overlooked point eloquently made in "Science, the Endless Frontier." *"If ability and not the circumstance of family fortune determines who shall receive higher education, then we shall be assured of constantly improving quality at every level of scientific activity."*

Now, to make all of this possible, Bush proposed the formation of a National Science Foundation that would literally be financially endowed by Congress. Ironically, President Truman essentially shelved this report and commissioned another one from a New York attorney, William T. Golden. Golden was in essence Truman's Science Adviser, in fact the first presidential Science Adviser. Bill Golden became a great friend, counselor and philanthropist of science. He died just last October at the age of 98.

Nonetheless, "Science, the Endless Frontier" is the foundation of U.S. science and technology policy to this very day. It led to the establishment indeed of the National Science Foundation, albeit in a somewhat different form than Vannevar Bush had envisioned.

From the earliest days of the post-war era, the Department of Defense also supported large amounts of research in graduate education in universities and later was joined by the National Institutes of Health. What emerged was a unique university based research system operating within a competitive marketplace of ideas. This system was intended to support the best ideas and proposals selected by a process of peer review.

The Vannevar Bush model assumed a linear progression from basic research to applied research to product design to marketing of new products and services. The Bush model was also one of *laissez faire*, that is, university's role was to produce the new knowledge and new technologies and the marketplace would decide what would be developed into new products and services. The realities of this have changed somewhat in recent years as described by the late Donald Stokes at Princeton in his book *Pasteur's Quadrant*, but that's a subject for another day.

Now, let me move to the present. My point today is that the federal government got into the business of supporting university research and advanced

education to promote the national welfare in a very pragmatic way. Federal support of universities since the end of World War II has rested almost entirely on two pillars: defense and health. The pillar of defense crumbled substantially after the Cold War ended and has to a large extent been replaced by innovation and economic competitiveness. Virtually all economists agree that since the end of World War II technological advancement has been responsible for over 50 percent of our economic growth, and much of that technological advancement had its origins in our universities.

Today, we have a very loosely organized innovation system of academia, government and industry working together to create new knowledge and technology through research to educate young men and women to create and understand such new knowledge and technology, and to move them into the marketplace as new products, processes and services. However, the constituencies of this system have very different motivations.

Students, I hope, study fields like science and engineering because of their curiosity and their passion for exploring the unknown and for discovery. Researchers are motivated by obsessive drive to solve extremely difficult intellectual challenges. Legislators want to produce jobs. And industry wants innovation, and wants it today. It is the role of science and technology policy to somehow make sense of all this or at least to devise a workable system.

There are some tensions in all of this. Basic scientists are the poets of my world. Engineers are its novelists. The engineer-novelists find their role in the innovation system and the rationale for federal funding to be perfectly reasonable. The basic scientist-poets may not. The young particle theorist or experimentalist undoubtedly believes that the government should fund his or her work for its own intrinsic sake, not because it might lead to a better weapon or to a new scheme to produce electrical power.

I happen to agree, but life is more complicated than that. Indeed our community has from time to time committed sin by making outlandish claims that sending humans into space will lead to the cure for cancer, for example. You humanists must take care to avoid comparable sins.

Now let's turn to the future. I briefly described the basic journey and structure of science and engineering funding by the federal government. How can I stand before my colleagues from the humanities knowing that what you do is also crucially important, knowing that the federal support of your work pales in comparison to that of science, engineering and certainly medicine and tell you that I am a passionate advocate for seriously increased funding for science, engineering and medicine?

The crux of the matter is that I am deeply worried about our future. Worried about the future prosperity and indeed the very quality of our nation in the world. In the 20<sup>th</sup> century, U.S. science, engineering and medicine nearly doubled our life

span, kept our nation secure, fueled most of our economic growth, sent us to the moon, fed the planet, brought world events into our living rooms, gave us freedom of travel by air, sea and land, established instant worldwide communication for virtually everyone, enabled ubiquitous new forms of art and entertainment and produced remarkable levels of understanding of our natural world. It was a century of speed, power and new horizons. We've come to take all this for granted.

The opportunities and challenges of the 21<sup>st</sup> century will be very different. And nothing can be taken for granted. To grasp the great opportunities of our times and to meet our great challenges from economic competitiveness to global change, from healthcare to education, from security to transportation, federal policy and action must be informed and enabled by a vibrant and potent science and technology enterprise. Indeed our national comparative advantage is a strong science and technology base coupled to a free market economy operated within a diverse and democratic society.

But the full force of global competition will soon be felt. The knowledge age demands people with knowledge, and much of that knowledge will need to be scientific and technological. Jobs will follow innovation wherever in the world it is found, and innovation will follow basic research wherever it is conducted.

Although I will not spend a large amount of time on this today, let me say bluntly that we are about to be hit between the eyes by the full force of global competition. While we have grown complacent and allowed our K thru 12 education to become a disaster, while we have allowed the funding for research in science and in engineering and the physical sciences to stagnate, and while for bizarre political reasons we have chosen to view globalization as a threat rather than as an opportunity, and while to far too large an extent we have pulled back the welcome mat to the best and brightest from around the world who have long provided a huge amount of our academic and entrepreneurial excellence, the rest of the world has latched on to our example and our system and is working hard to simply outpace us.

If we want the well paying jobs of the future and if we want to be leaders in the grand challenges to human life on this planet and its sustainability, we cannot let this stand. In the 20<sup>th</sup> century, we had all of these accomplishments, but as I have said, things will be much different in the 21<sup>st</sup>. We must have a sense of urgency about this, and that is why I am a tireless advocate for strong, well-funded partnerships among academia, government and industry. I believe we owe it to our children and grandchildren.

But this review brings me to two questions. Is this emphasis on science and engineering causing an improper distortion of our universities and our knowledge system? And are there lessons in this experience for the humanities?

I believe that the answer to the question of whether we are distorting the very purposes of education, research and scholarship is no. The two cultures are

both important to the modern world and must not only coexist but constantly seek synergy and common understanding. The great challenges before us, things such as providing clean water for all people, creating a sustainable world, adapting to global change, feeding the world's burgeoning population, delivering healthcare, providing energy and reducing vulnerability to both human and natural threats all require the advancement, tools and knowledge of science, engineering and medicine. They are the sine qua non.

But meeting all these challenges requires the development of huge engineering systems in the vernacular of my profession. And such engineering systems interact with and serve people, economies, business, law, politics, culture and so forth. Without political will, none of these challenges will be met even if science and engineering develop the knowledge and the technologies to do so. And political will, as I use it here, must be driven by our vision, our underlying values, our world view, our culture, our appreciation of nature and of people, our ability to envision a future that is different from our past, our willingness to transcend narrow interests and boundaries, our ability to inspire, the necessity to understand the lessons of the past, the wise application of rhetoric, the ability to find common cause, the development of effective communications and the use of critical thinking to make difficult choices among disparate and yet important goals. In other words, we require the very stuff of humanities.

And just as we seem to have our heads in the sand regarding the strength of global competition, and the realities of globalization, we also seem to be politically oblivious to the coming ethical challenges and societal choices presented by the increasing depth of scientific understanding in the life sciences and the attendant development of new technologies based on them. Matters like personalized predictive medicine, engineered life forms, genetic manipulation, large scale use of biomass for fuel, adaptation to global change, privacy of information and so many more things on the near or distant horizon will need to be resolved.

As my esteemed colleague and former Economics Minister of Japan Koji Omi states, "Science presents us with both light and shadow." In a democracy and indeed in any worthy civil society, these choices and judgments are not just the provinces of scientists and engineers. They are the provinces of culture, and of societal and political discourse founded, I certainly hope, deeply in the humanities.

In the academic context and in the social context, I believe that the humanities are important for their own sake. Period. They should not need to be justified by utilitarian arguments. Above all, they should not need to be distorted, diluted, diverted or tailored to other purposes to justify their existence. But to the extent that we seek government support for humanistic scholarship, research and education, we must be cognizant of the proper role of government and the interests and responsibilities of legislators, just as in the case of science, technology and medicine.

In that spirit, let me state one personal opinion about what one might consider to be a utility of the humanities. As I noted briefly today, much of the rest of the world is bearing down on us in its commitment to the education of engineers and the promotion of innovation to drive industry and economists. This is an urgent matter. What is happening in China, India, Singapore, Finland, Ireland and so many other countries is simply astounding. We must wake up before it is too late.

But having said that, for the most part in these countries universities are viewed and constructed with very narrow, highly utilitarian, technology centered approaches. I am convinced that one comparative advantage we in the United States retain at least for a few years is that we educate our engineers in a milieu in which science and engineering education are mixed in a great stew with the humanities, the arts and the social sciences. I am convinced, though some disagree, that this greatly enhances the creativity and innovativeness of our graduates.

This U.S. comparative advantage in global economic competition will not last long. Singapore, for example, has figured this out and is moving rapidly to strengthen the liberal arts in its national university. China and others will undoubtedly follow soon.

One domain where the humanities and the sciences have clear common cause is in cyberspace in the new evolving digital world. This, of course, would be the subject of an entire seminar, and I know that some of you are giving it attention today. But suffice it to say that how our cyber infrastructure develops and is deployed, what policies are adopted regarding digital intellectual property, how the privacy of digital communications and records is protected, and how the movement toward open, scholarly and educational content develops are all of critical importance to humanists, scientists and technologists alike.

So there are many things that we have to consider together, many synergies and a very different history in terms of our support by the federal government. I began spending time in this city as an advocate on behalf of higher education and on behalf of science and research out of necessity because about the time I came to MIT in 1990 we really were at rock bottom in terms of the relationship between our research universities and the federal government. There are many reasons for that, but the fact is that was the way it was.

I decided that I would spend a day every month coming to this city, knocking on doors, talking to anybody who'd listen, whether or not they cared about what I had to say about the fundamental importance of research, scholarship and advanced education. Now, what happens as you could tell by John's introduction is that after you do that for a while your name begins to be in the back of people's mind and so every time they want to fill a committee you get a phone call and pretty soon you find yourself in and out of Washington very frequently. So finally we just gave up and moved down here.

But during this time I've learned a few lessons, and I hope that they might be important as you think about the conduct of your advocacy on behalf of the humanities. So here are my rules.

Maintain a steady, consistent drumbeat over many years. One year of messages, one visit to a congressman will accomplish nothing. It takes time. Maintain a steady, consistent drumbeat over the long haul.

Speak with a uniform voice. Eliminate the cacophony of special interests and narrow agendas. If you take away nothing from this lunch talk than that, please take this away. Speak as best you can in a uniform voice. Eliminate the cacophony of individual specific interests and narrow agendas.

Keep your messages basic, brief and consistent. If in the unlikely event that any arrogance exists in your community, check it at the door. Believe me. Check it at the door. I could give you a whole talk on how most people in the halls of Congress view us. Check your arrogance at the door.

Never forget that staffs do the vast majority of the work, both in the Congress and in the agencies. Respect them. Talk to them. Work with them.

Be passionate but objective and factual. I think among other things this means that you need in a concerted way to gather, analyze and present clear, longitudinal data about funding and about accomplishments of your community. Use a few factual human anecdotes, things about real people to accentuate your points. Be passionate, objective and factual.

Remember that your objectives and those of the legislatures may be different, but there are certainly areas of common cause. Do not shy away from pragmatic and utilitarian arguments, but be sure if you use them that they are well reasoned and honest.

In closing, let me remind you that when he was President, John F. Kennedy was once asked why our nation's capitol is located here in Washington, D.C. And his answer was that Washington combines the charm of the North with the efficiency of the South. So I hope that my remarks have similarly combined the charm of engineering with the efficiency of the humanities.

Thank you very much.